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SOLVING FUZZY ASSIGNMENT PROBLEM IN A NEW METHOD USING ROBUST RANKING PROCEDURE

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ABSTRACT

The Fuzzy Assignment Problem (FAP) is a classic combinatorial optimization problem that has received a lot of attention. FAP has a wide range of uses. We suggest a new algorithm that combines to solve the FAP in this paper. Each column is maximized during the optimization process, and the best choice with the lowest cost is selected. The proposed method follows a standard methodology, is simple to execute, and takes less effort to compute. An order to obtain the best solution, the assignment problem is specifically solved here. We looked at how well trapezoidal fuzzy numbers performed. Then, to convert crisp numbers, we use the robust ranking method for trapezoidal fuzzy numbers. The optimality of the result provided by this new method is clarified by a numerical example.

Keywords: Trapezoidal Fuzzy Number, Robust Ranking Method, Fuzzy Assignment Problem, New Algorithm

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1. INTRODUCTION

The Assignment Problem (AP) may be a sort of applied mathematics problem (LPP) during which the goal is to assign variety of sources to an equal number of destinations at the minimum available cost (or maximum profit). The assignment problem may be a basic combinatorial optimization problem within the branch of mathematics referred to as optimization and operations analysis. Various methods for solving the assignment problem are introduced, and a number of other papers on the topic are written. The mathematical formulation of the matter proposes that new algorithms be built to seek out optimal Assignment Problem solutions. Assume you've got an assignment problem with n machines and n jobs, and you would like to scale back the general cost or time by assigning each machine to at least one and just one employee.

The aim of the assignment problem is to allocate variety of sources to an equal number of destinations at all-time low possible expense (or maximum profit) on a one-to-one basis. The assignment problems are often seen during a number of situations. Allocation of 'n' workers to 'n' machinery is during a factory. To Resolve Assignment issues The Hungarian method is that the commonest, but it appears to be repetitive as compared to the iterative method. The algorithmic step involves finding the utmost (or minimum) element in each row and subtracting each element of the row by using the maximum (or minimum) element so as to get any zeros within the cost matrix, after which an entire assignment comes by allocating 0's based location.

In this article, we presented a method for solving the Fuzzy Assignment Problem (FAP) with a fuzzy cost. The objective function is often treated as a fuzzy number, subject to these sharp constraints, since the objectives are to reduce total cost or maximize total gain. Then, using Robust's ranking method, rank the objective values of the objective function in order to transform the Fuzzy Assignment Problem into a crisp one that can be solved using traditional solution approaches. The aim is to transform a problem with fuzzy parameters into a problem with crisp parameters, which can then be solved with a new algorithm process. Many ranking methods, such as Robust's ranking system, which satisfies the properties of compensation, linearity, and addictiveness, will explain the dominance of fuzzy numbers. The fundamental concepts of fuzzy sets, fuzzy numbers, and fuzzy linear programming were also covered by Srinivasan et al [7&8]. (FLP). A robusts ranking is discussed by Nagarajan et al. [2–5]. Thiruppathiet has proposed a new algorithm, al[11&3]. Srinivasanet.al [6] focuses on a single task in order to find the best answer. The operation analysis has been discussed by Taha[9]. Thakreet.al [10] has discussed various methods for achieving the lowest rate. Zadeh [12] was the first to propose the concept of fuzzy sets.

2. PRELIMINARIES

2.1. Definition: (Fuzzy Set)

A membership function mapping the components of a domain space or universe of discourse X to the unit interval [0,1] defines a fuzzy set. $(i.e)\ddot{\mu}_{\bar{A}}(x): X \to [0,1]$

2.2. Definition: (Fuzzy number)

Assume $\dot{A}$ is a classical set, and $\ddot{\mu}_{\bar{A}}(x)$ is a function from $\dot{A}$ to [0,1]. The membership function $\ddot{\mu}_{\bar{A}}(x)$ of a fuzzy set $\dot{A}$ is known as $\dot{A} = \{(x, \ddot{\mu}_{\bar{A}}(x)); \text{x}\varepsilon\ \dot{\text{A}}$ and $\ddot{\mu}_{\bar{A}}(x)\varepsilon\,[0,1]$

2.3. Definition: (Trapezoidal Fuzzy Number)

A trapezoidal fuzzy number $\dot{A}$ is represented by $\dot{A} = (a,b,c,d;1)$ with the membership function

$$\ddot{\mu}_{\bar{A}}(x) = \begin{cases} \dfrac{x-a}{b-a} & a \le x \le b \\ 1 & b \le x \le c \\ \dfrac{d-x}{d-c} & c \le x \le d \\ 0 & otherwise \end{cases}$$

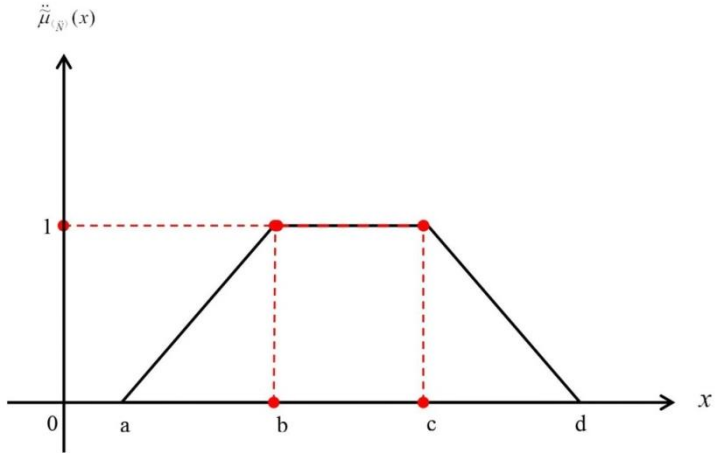

Figure 1 Trapezoidal Fuzzy Number

2.4. Definition: α-Cut

$\dot{A}(\alpha)=\left(x:\ddot{\mu}_{\hat{A}}(x)\geq\alpha,\alpha\,\varepsilon[0,1]\right)$is the concept of the α-cut of a fuzzy number $\dot{A}$. The addition of two fuzzy numbers is $(a+b+c)+(d+e+f)=(a+d,b+c,e+f)$.The sum of two trapezoidal fuzzy numbers is $(a+b+c+d)+(e+f+g+h)=(a+e,b+f,c+g,d+h)$

3. ROBUST RANKING TECHNIQUE

The Robust's Ranking Index is represented by $\ddot{a}$ when given a convex fuzzy number.

$RR(\breve{a})=\frac{1}{2}\int_0^1\left(a_\alpha^l,a_\alpha^u\right)d\alpha$, where $\left(a_\alpha^l,a_\alpha^u\right)=\{(b-a)\alpha+a,d-(d-c)\alpha\}$

4. FUZZY ASSIGNMENT PROBLEM

Assume there are n tasks to be completed and n people willing to complete them. Assume that each individual will do each task at the same time, but with an unreliable level of performance. The fuzzy assignment problem can be expressed in the form of an $n\times n$ as a fuzzy cost matrix FAP_{ij} as seen below

Table 1

Machines	**Operators**				
	1	**2**	**3**	**…j…**	N
1	FAP_{11}	FAP_{12}	FAP_{13}	.. FAP_{1j} ..	FAP_{1n}
2	FAP_{21}	FAP_{22}	FAP_{23}	.. FAP_{2j} ...	FAP_{2n}
-					
i	FAP_{i1}	FAP_{i2}	FAP_{i3}	.. FAP_{ij} ..	FAP_{in}
-					
N	FAP_{n1}	FAP_{n2}	FAP_{n3}	.. FAP_{nj} ..	FAP_{nn}

Fuzzy Assignment Problem can be expressed as

$$Min\ \hat{w}=\sum_{i=1}^{n}\sum_{j=1}^{n}FAP_{ij}t_{ij}$$

Sub to constraints

$$\sum_{i=1}^{n} t_{ij} = 1 \text{ , } \text{j} = 1,2,.....\text{n}$$

$$\sum_{j=1}^{n} t_{ij} = 1, \text{ i} = 1,2.....\text{n}$$

and $\text{t}_{\text{ij}} = 0 \ (\text{or}) \ 1$

Where i^{th} machine is assigned to the j^{th} operator.

5. NEW ALGORITHMIC APPROACH FOR SOLVING FUZZY ASSIGNMENT PROBLEM

Step – 1: Make the cost matrix. Consider the rows for people and the columns for work.

Step – 2: Find and write the highest element in each column of the assignment matrix.

Step – 3: Select the smallest value in the maximum column. Then divide the FAP in each row and column of the matrix by its minimum value.

Step – 4: After dividing by the minimum column value, choose and assign the lowest value in the same column. Then, remove the whole row and column.

Step – 5: Continue to step 2 after finishing step 4.

Step – 6: Repeat steps 3–5 for the FAP, assigning each row and column.

Step – 7: Evaluate the best solution.

6. NUMERICAL EXAMPLE

Find a Fuzzy Assignment Problem with four rows representing four workers (job1, job2, job3, and job4)and four columns representing four people (A, B, C, D) .The cost matrix, whose elements are trapezoidal fuzzy numbers, is given.

A fuzzy assignment problem is solved using the proposed approach to illustrate the proposed method.

$$A = \begin{bmatrix} (3,5,6,7) & (5,8,11,12) & (9,10,11,15) & (5,8,10,11) \\ (7,8,10,11) & (3,5,6,7) & (6,8,10,12) & (5,8,9,10) \\ (2,4,5,6) & (5,7,10,11) & (8,11,13,15) & (4,6,7,10) \\ (6,8,10,12) & (2,5,6,7) & (5,7,10,11) & (2,4,5,7) \end{bmatrix}$$

Solution

Given Trapezoidal fuzzy cost matrix is balanced one. Fuzzy assignment problem can beformulated in the following

$$Min\left\{\begin{array}{l} RR(3,5,6,7)x_{11} + RR(5,8,11,12)x_{12} + RR(9,10,11,15)x_{13} + RR(5,8,10,11)x_{14} \\ + RR(7,8,10,11)x_{21} + RR(3,5,6,7)x_{22} + RR(6,8,10,12)x_{23} + RR(5,8,9,10)x_{24} \\ + RR(2,4,5,6)x_{31} + RR(5,7,10,11)x_{32} + RR(8,11,13,15)x_{33} + RR(4,6,7,10)x_{34} \\ + RR(6,8,10,12)x_{41} + RR(2,5,6,7)x_{42} + RR(5,7,10,11)x_{43} + RR(2,4,5,7)x_{44} \end{array}\right\}$$

Subject to

$x_{11} + x_{12} + x_{13} + x_{14} = 1 \qquad x_{11} + x_{21} + x_{31} + x_{41} = 1$

$x_{21} + x_{22} + x_{23} + x_{24} = 1 \qquad x_{12} + x_{22} + x_{32} + x_{42} = 1$

$x_{31} + x_{32} + x_{33} + x_{34} = 1 \qquad x_{13} + x_{23} + x_{33} + x_{43} = 1$

$x_{41} + x_{42} + x_{43} + x_{44} = 1 \qquad x_{14} + x_{24} + x_{34} + x_{44} = 1$

Now we calculate RR(3,5,6,7) by applying the Robust's ranking method.

Themembership function of the trapezoidal fuzzy number (3, 5, 6, 7) is

$$\ddot{\mu}_{\breve{A}}(x) = \begin{cases} \frac{x - 3}{2} & 3 \le x \le 5 \\ 1 & 5 \le x \le 6 \\ \frac{7 - x}{1} & 6 \le x \le 7 \\ 0 & otherwise \end{cases}$$

The α *cut* of the fuzzy number (3,5,6,7) is

$$\left(a_\alpha^l, a_\alpha^u\right) = (2\alpha + 3, 7 - \alpha)$$

$$RR(\breve{a}) = \int_0^1 0.5\left(a_\alpha^l, a_\alpha^u\right)d\alpha$$

$$RR(\breve{a}_{11}) = \int_0^1 0.5\left(a_\alpha^l + a_\alpha^u\right)d\alpha \quad = \quad RR(\breve{a}) = \int_0^1 0.5(10 + \alpha)d\alpha$$

$$RR(\breve{a}_{11}) = 5.25$$

Proceeding similarly, the Robust's ranking indices for fuzzy cost Aare calculated as

$RR(\breve{a}_{12}) = 9, RR(\breve{a}_{13}) = 11.25, RR(\breve{a}_{14}) = 8,$

$RR(\breve{a}_{21}) = 9, RR(\breve{a}_{22}) = 5.25, RR(\breve{a}_{23}) = 9, RR(\breve{a}_{24}) = 8$

$RR(\breve{a}_{31}) = 4.25, RR(\breve{a}_{32}) = 8.25, RR(\breve{a}_{33}) = 11.75, RR(\breve{a}_{34}) = 6.75$

$RR(\breve{a}_{41}) = 9, RR(\breve{a}_{42}) = 5, RR(\breve{a}_{43}) = 8.25, RR(\breve{a}_{44}) = 4.5$

$$A = \begin{bmatrix} 5.25 & 9 & 11.25 & 8 \\ 9 & 5.25 & 9 & 8 \\ 4.25 & 8.25 & 11.75 & 6.75 \\ 9 & 5 & 8.25 & 4.5 \end{bmatrix}$$

STEP 1: Find and write the highest element in each column of the assignment matrix.

Table 2

	I	**II**	**III**	**IV**
A	5.25	9	11.25	8
B	9	5.25	9	8
C	4.25	8.25	11.75	6.75
D	9	5	8.25	4.5
COL MAX	9	9	11.75	**(8)**

STEP 2: Select the smallest value in the maximum column. Then divide the FAP in each row and column of the matrix by its minimum value.

Table 3

	I	**II**	**III**	**IV**
A	5.25/8	9/8	11.25/8	8/8
B	9/8	5.25/8	9/8	8/8
C	4.25/8	8.25/8	11.75/8	6.75/8
D	9/8	5/8	8.25/8	4.5/8

STEP 3: Choose and assign the lowest value in the same column. Then, remove the whole row and column.

Table 4

	I	**II**	**III**	**IV**
A	0.656	1.125	1.406	**1**
B	1.125	0.656	1.125	**1**
C	0.531	1.031	1.469	**0.844**
D	**1.125**	**0.625**	**1.031**	**(0.563)**

Job D assigns to Person IV. Delete the entire row and column.

STEP 4: Repeat steps 3–5 for the FAP, assigning each row and column.

Table 4

	I	**II**	**III**
A	0.656	1.125	1.406
B	1.125	0.656	1.125
C	0.531	1.031	1.469

	I	**II**	**III**
A	5.25	9	11.25
B	9	5.25	9
C	4.25	8.25	11.75
COL MAX	(9)	9	11.75

	I	**II**	**III**
A	5.25/9	9/9	11.25/9
B	9/9	5.25/9	9/9
C	4.25/9	8.25/9	11.75/9

	I	II	III
A	0.583	1	1.250
B	1	0.583	1
C	(0.472)	0.917	1.306

Job C Assign to Person I. Delete the entire row and column.

	II	III
A	1	1.250
B	0.583	1

Step 5:

Table 5

	II	III
A	9	11.25
B	5.25	9
COL MAX	(9)	11.25

	II	III
A	9/9	11.25/9
B	5.25/9	9/9

	II	III
A	1	(1.250)
B	(0.583)	1

Job B Assign to Person II.

Job A assign to Person III

Optimal cost =A-III, B-II,C-I,D-IV=11.25+5.25+4.25+4.5=25.250

7. CONCLUSION

This paper introduced a new simple and effective method for solving the fuzzy assignment problem. This method applies to all types of fuzzy assignment problems. The new approach is a standardized technique that is simple to implement and can be used for any form of assignment problem, whether the objective function is maximized or minimized.

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